Benefits of Better Air

Pinpointing Effects on Subpopulations

Reducing air pollution confers health benefits to the population as a whole, but researchers at the Harvard School of Public Health have found a way to predict benefits that may accrue to particular subpopulations, such as lower-income individuals and minorities, who suffer from higher rates of illnesses affected by air pollution [*EHP* **110:1253–1260**]. This information could help federal and state policy makers further refine debates over the costs and benefits of proposed air pollution controls.

Cost–benefit analyses typically use a conventional unstratified approach, applying the same relative risks to all individuals in an at-risk age group, and assuming baseline disease or health care utilization rates to be uniform across large geographic areas. To better quantify health benefits associated with implementing Best Available Control Technologies (BACT) for reducing emissions, Jonathan Levy and colleagues have developed a model to estimate health benefits for different demographic groups across small-scale geographic areas. Theirs is one of the first studies to attempt to capture benefits for specific subpopulations.

The team modeled health benefits from the hypothetical installation of BACT at five older power plants located within a 50-mile radius of Washington, D.C. They focused on the effects of reducing emissions of primary fine particulate matter and secondary sulfate and nitrate particles formed through emissions of sulfur dioxide and nitrogen oxide, respectively.

BACT up by data. New research shows that the benefits of Best Available Control Technologies for air pollution accrue to those most affected by it, including minority and low-income children.

EyeWire

The team performed atmospheric modeling using CALPUFF, a regional-scale model recommended by the U.S. Environmental Protection Agency for long-range transport modeling. They modeled concentration reductions at small geographic scales—census tracts for areas within 100 kilometers of Washington and counties outside of that—to better show the impacts that such reductions would have on smaller subpopulations.

The team then established a grid encompassing a 400-kilometer radius around Washington. For the population contained within this grid, they evaluated three health end points: premature mortality, cardiovascular-related hospital admissions for the elderly, and asthma-related emergency room visits for children. Premature mortality was stratified by subjects' educational level, cardiovascular-related hospital admissions were stratified by diabetic status and age, and asthma-related emergency room visits were stratified by race and age.

The team analyzed outcomes both by using a conventional unstratified approach and by considering susceptible populations. Using the conventional approach, they estimated that implementing BACT would result in 210 fewer deaths per year in the target area, with approximately 25% of the benefits accruing to individuals with less than a high school education. However, the susceptibility model predicted that 51% of the estimated mortality benefits would accrue to that subpopulation—more than double the prediction of the conventional model. Similarly, the conventional model showed only 13% of health benefits from pollution controls accruing to diabetics, whereas the susceptibility model showed 54% of the benefits accruing to diabetics. Finally, the conventional model estimated 140 fewer pediatric asthma emergency room visits per year, with 27% of those benefits accruing to African-American children. The stratified model estimated 160 fewer visits per year, with 64% of the benefits going to African-American children.

Levy and colleagues write, "Although our ability to characterize subpopulations is constrained by the available information, our analysis demonstrates that incorporation of susceptibility information significantly affects demographic and geographic patterns of health benefits and enhances our understanding of individuals likely to benefit from emission controls." According to the researchers, the influence of the susceptibility assumptions on the distribution of benefits highlights the need for more epidemiological studies targeting high-risk subpopulations. **–John S. Manuel**

Cadmium Cause and Effect

Looking at Renal Function

Exposure to high concentrations of cadmium, as in industrial settings, can lead to renal failure, but kidney problems can arise even from low-level cadmium exposures. In this month's issue, a group of scientists led by Ing-Marie Olsson of the Swedish University of Agricultural Sciences investigates the relationship between cadmium intake from various sources, cadmium retention, and kidney function [*EHP* **110:1185–1190**]. They found that, although most of the subjects had relatively low cadmium intake, the cadmium did appear to have an adverse effect on kidney function.

The study subjects were heterosexual couples living on farms in the Skåne province of southern Sweden. The soil in this area is relatively high in cadmium. Some of the cadmium occurs naturally, some comes from phosphate fertilizers once used intensively in farming, and some comes from clouds of industrial pollution originating in central Europe.

Demographic and lifestyle factors may affect how people are exposed nonoccupationally to cadmium. For example, nonsmokers absorb most of their cadmium from food and water, but because tobacco draws cadmium from soil, smokers may absorb half their exposure from cigarettes. The researchers surveyed the subjects on their diets and smoking habits. They estimated the amount of cadmium the subjects ingested through foods and assigned cadmium values to these different eating patterns, based on existing literature. They also calculated the amount of cadmium the subjects got from water by measuring the metal in the subjects' wells and estimating the amount of water, tea, coffee, and juice they drank.

Even at the lowest exposure level, there was an indication of effect on kidney function, and higher concentrations of urine cadmium (UCd) correlated to reduced kidney performance. As expected, the researchers found that individuals with high blood cadmium (BCd) also had high UCd. However, cadmium consumption did not correlate with UCd or BCd, a finding that has been previously reported at low exposures. This may be because of the subjects' low average dietary intake of cadmium, because of variation in the bioavailability of the cadmium in the subjects' food and water, or because of uncertainties in the estimated intake of cadmium from food.

The women's BCd was about 1.4 higher than that of the men, and their UCd was about 1.6 times higher than the men's. In a subgroup of the sample—couples in which neither person had ever been a smoker—the women had lower intakes per body weight of cadmium than men, but had 1.8 times higher BCd and 1.4 times higher UCd. This may be due, the researchers say, to the lower iron status typical of premenopausal women, because lower iron levels have been linked to increased cadmium retention. In spite of the relationship between low iron status and higher cadmium levels, subjects who took vitamins, which usually contain iron, had higher BCd and UCd levels. The researchers suggest that the vitamins may have been contaminated with cadmium, as has happened before with vitamin–mineral supplements used for pig feed.

The researchers also compared cadmium levels in the kidneys of slaughtered pigs with the BCd and UCd of people living on the farms on which the animals were raised. Because the pigs were fed locally grown grain, their kidney cadmium levels was presumed to reflect the cadmium levels in the soil. But cadmium levels in the pigs did not predict cadmium levels in people living on the same farms. A possible explanation, the researchers say, is that much of the cereals and other foods that the subjects ate wasn't grown locally; another is that ingredients besides locally produced grain were contributing to the pigs' cadmium intake. **–Scott Fields**

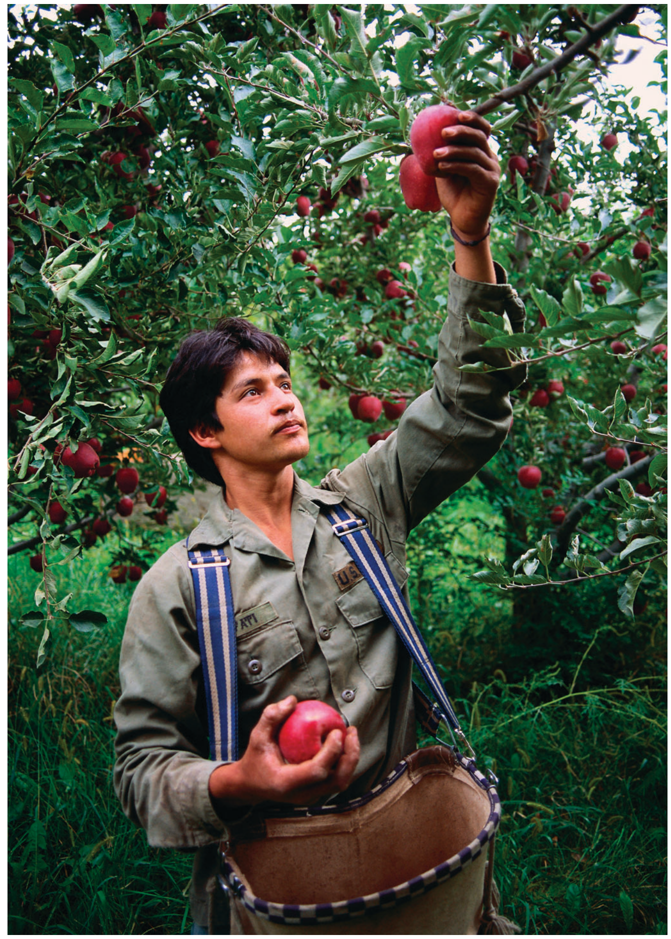
Bringing Home More than a Paycheck

Workers and Pesticides

Agricultural workers exposed to pesticides in the course of their labors may transport those chemicals to their residences, putting children in their homes at risk of potentially dangerous exposure to contaminants. This "take-home" exposure pathway has been shown to be a significant contributor to residential contamination in the homes of agricultural workers. In this month's issue, a team of investigators from the University of Washington and the Fred Hutchinson Cancer Research Center reports the results of their 1999 study of 218 farmworker households in the Yakima Valley area of Washington state [*EHP* **110:A789–A794**]. Their findings lend further credence to the take-home exposure pathway hypothesis.

The researchers collected dust samples from 156 homes and 190 commuting vehicles, as well as urine samples from the adult farmworkers themselves and a child between the ages of 2 and 6 in each household. Dust samples were analyzed for the presence of six organophosphorus (OP) pesticides commonly applied to the apple, pear, and cherry crops raised in the area: azinphosmethyl, malathion, methyl parathion, phosmet, chlorpyrifos, and diazinon. Urine samples were analyzed to detect five dialkylphosphate (DAP) compounds produced by the metabolism of most OP pesticides.

Azinphosmethyl was the most commonly detected compound. It was found in 85% of the household dust samples and 87% of the vehicle dust samples—more than an order of magnitude higher than concentrations of any of the other pesticides in either household or vehicle dust. These relatively high concentrations correspond with the heavy use of the pesticide on fruit crops in the state in 1999. There was a significant association between azinphosmethyl concentrations in the vehicle and household dust samples from the same residence, supporting the likelihood that the pesticide was transported from the clothing or skin of the workers exposed in the field into their vehicles, and then into their homes. Although the researchers



Corbis

Harvesting hazards. Agricultural workers may "wear" pesticides on their clothing and transfer the chemicals to their homes and families.

are careful to point out that spray drift of the pesticide from application to fields near the homes cannot be ruled out as a potential source of residential exposure, questionnaires completed by the participants included information about their homes' proximity to treated fields, and those data did not reveal a significant pattern. This led the investigators to conclude that spray drift is unlikely to have confounded the association they discovered.

Urine sample analysis showed that one of the metabolites of azinphosmethyl was present in the urine of 88% of the children and 92% of the adults. Further, there was a significant association between dimethyl DAP levels in the urine of children and adults from the same household. Although possible confounding—exposure to a variety of OP pesticides and not only those used exclusively in agriculture—makes these findings less persuasive than the vehicle and household dust association, they still lend further support to the take-home exposure pathway hypothesis.

One of the goals of this study was to establish baseline exposure information for use in the evaluation of a community intervention project intended to reduce take-home exposure in 24 agricultural communities in the Yakima Valley area. After the 1999 sample collections, the communities were randomized into either intervention or control status, and in 2002 similar measurements were collected. These more recent data will not only shed light on the effectiveness of the intervention project, but should also add to the weight of evidence suggesting that the take-home pathway is putting the children of agricultural workers at risk for adverse health effects from exposure to these acutely toxic compounds. **–Ernie Hood**